

## PERIDINEAE OF NEW SOUTH WALES.

BY G. I. PLAYFAIR.

(With Plates xli.-xliii. and 19 Text-figures.)

No definite effort was made to collect the species of *Peridineae* which form the subject of this paper; they are merely such as happened to be occluded in various gatherings made principally for freshwater algæ. Nevertheless a very fair representation has been obtained and most of the forms noted have been confirmed from several localities. Only two districts have been worked, viz. Sydney and Lismore in New South Wales, but with regard to these minute organisms, forms observed in one district are certain to occur under similar conditions wide-spread throughout the State. Corroborative evidence has been admitted in some cases from Brisbane, Queensland, but only one variety not yet found here has been mentioned viz. *Peridinium umbonatum* var. *inaequale* Lemm., a single cell of which was found in a Brisbane sample.

Altogether 39 varieties have been listed, distributed thus:—*Hemidinium* 1, *Gymnodinium* 4, *Glenodinium* 3, *Peridinium* 27, *Ceratium* 1, *Exuviella* 3. Figures of all forms are given (from Australian specimens) except in the case of *Ceratium hirundinella* and *Gym. aeruginosum*.

*Types*.—Owing partly to inexperience, partly to unsuitable lenses and lack of a good guide to the Order,\* the notes on *Peri-*

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\*The present paper was only made possible through my coming into possession of a copy of Dr. A. J. Schilling's "Dinoflagellatæ" 1913 (in Dr. A. Pascher's "Die Süßwasser-flora Deutschlands, Osterreichs und der Schweiz") a most useful little brochure with excellent illustrations of all the freshwater forms known from Central Europe, in most cases after the original types. I have not yet succeeded in obtaining Dr. Schutt's "Gymnodiniaceæ" (Engler and Prantl-Die natürlichen pflanzenfamilien).

*dineae* in my former paper "Plankton of the Sydney Water-Supply" left much to be desired. They have now been carefully revised, the nomenclature corrected, the types checked from the original samples and better figures supplied. A source of considerable error at that time was the expectation of finding here a considerable number of European types. On the contrary, up to date only two such have been recognised viz. *P. Willei* Huitfeld-Kaas, and *P. umbonatum* var. *inaequale* Lemm. and even these were not quite the same as the published types. Also, the larger European forms all have areolate membranes with the exception of *P. Westii* Lemm. in which the membrane seems to be of the same character as in *P. hieroglyphicum* mihi. But in our waters are found no less than five distinct types of membrane besides, viz. granular, striolate, scalariform, ridged, and banded. These give the cell such a distinct appearance that in spite of some similarity in the epivalve I have not considered it reasonable to arrange them under the nearest European type. There are also, in almost all cases, other differences, slight perhaps but well-marked and characteristic, and it seems to me unwise to complicate a distinct type by the inclusion within it of another type. Their connection can be much better recognised by forming them into groups such, for instance, as (1) the *P. tabulatum* group to which *P. bipes* Stein and *P. striolatum* mihi belong; (2) the *P. cinctum* group under which fall *P. Westii* Lemm., *P. granulosum* mihi and *P. zonatum* mihi; (3) the *P. Willei* group including *P. australe* mihi and *P. hieroglyphicum* mihi. There will be found also, connected with each of these types, quite a number of distinct variations, partly caused by differences in dimensions and partly the result of various modes of growth. For example, whether the cell is angular (faceted) or rounded, that is, whether the plates are concave or convex, makes a vast difference to the appearance of a specimen, while at the same time the arrangement of the plates may be identical. I found it difficult to persuade myself to place var. *gulfordense* under *P. caudatum*.

*Polymorphism*.—Wider experience of the *Peridineae* and closer study of the various forms has convinced me that the lumping together of the various types is inexpedient even if it can be maintained from a biological point of view. Nevertheless this closer study has itself brought to light a phenomenon which seems to point to polymorphism through diverging lines of de-

velopment for its solution. In the following notes, if the figures (dorsal view) of *P. caudatum* var. *guildfordense* (Text-fig. 5, a) *P. geminum* type (Text-fig. 9, a) and *P. umbonatum* var. *centenniale* (Text-fig. 14, a) be compared, it will at once be seen that not only are they all of a size and of quite remarkable similarity in characteristics, but that *P. geminum* holds the central position between the other two. In that species four plates meet at a point a little below the apex. Let this point become either a vertical line by longitudinal development, or a horizontal line by transverse growth and either *P. caudatum* var. *guildfordense* or *P. umbonatum* var. *centenniale* is the result. From their minute size it is certain that all three are the outgrowth of resting-cells such as I have already figured (*op. cit.*, Pl. lvii., f. 4). Is it not possible, though they are representatives of distinct types (types which are still more distinct in their larger and more mature forms) that they are the results of three diverging lines of growth from the same resting-cell?

*General remarks.*—There is another point that calls for remark. Such a large proportion of the cells have the antapical plates set obliquely; very often also the apex of the epivalve is eccentric. This is neither a specific nor varietal characteristic, but is common to almost all cells in which the hypovalve is not regularly domed over and the terminus of the longitudinal furrow definitely fixed. Along with this peculiarity goes another viz. that the transverse furrow is more or less spiral, being dragged downwards *always on the left side* in ventral view. In such cells, the fact is, there are two longitudinal axes, a dorsal which is straight and vertical, and a ventral which is curved (*cf.* Text-figs. 14, 15; Pl. xli., fig. 3 b, b').

The convex side of the curve is *always on the left* in ventral view, and the plane of the antapical plates is at right angles to the curved axis, hence its obliquity with respect to the other. The apical pit in the epivalve, which always tends to be ventral rather than dorsal, is very often drawn aside (but to a less extent) conformably to the same influence. As I consider the shape and relative proportions of the antapical plates to be of more importance than their position on the cell I have always drawn the diagram of the hypovalves on the oblique plane. The cause of this asymmetry seems to be a longer period of growth (or a stronger growth) on one side, this perhaps being due to the greater action there of the tip of the transverse flagellum.

## DINOFLAGELLATAE or PERIDINEAE.

## Genus HEMIDINIUM Stein.

## HEMIDINIUM NASUTUM Stein. (Text-fig. 1, c).

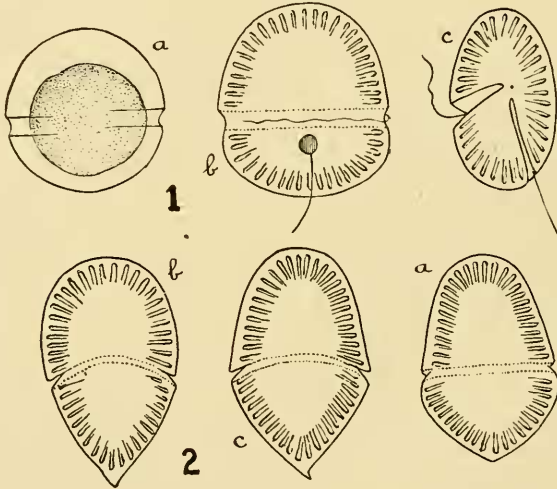
Long. 24-28, lat. 14-17  $\mu$ . Lismore (302, 332, 345, 347); Byron Bay.

Doubtless widespread in swamps and pools, but only noted from the localities named. Exactly the size given by Schilling.

## Genus GYMNOINIUM.

## GYMNOINIUM AERUGINOSUM Stein.

Specimens noted in March, 1909, from the Gardener's Road swamp, Botany, are supposed to represent this species. In size and appearance they tallied fairly well with the figures given by Schilling (*Dinoflagellatae*, p. 19, f. 18) but the contents were a



Text-fig.1.

(a) *Glenodinium oculatum* var. *circulatum*, n. var. (x 660); (b) *Gymnodinium paradoxum* Schilling, forma (x 660); (c) *Hemidinium nasutum* Stein (x 1000).

Text-fig.2.

(a) *Gymnodinium australe* mihi; (b, c) var. *acutum*, n. var. (x 500).

dull violet blue, not blue-green. Accompanying them were others of similar size and shape but with the usual yellow-brown chromatophores. The movements of the two were widely different however, the blue form darting rapidly here and there in a very lively manner indeed.

Long. 30, lat. 25  $\mu$ . Botany (108).

GYMNODINIUM PARADOXUM Schilling. (Text-fig. 1 b).

Forma parte anteriore latissime rotundata, altius crateriformi, parte posteriore magis depressa, fossa transversa magis distincta.

Long. 38, lat. 34  $\mu$ . Lismore (347).

Exactly the size recorded by Schilling, *l.c.*, p. 18, f. 15, who gives long. 39.7, lat. 34.5  $\mu$ . Our form however has the anterior part more broadly rounded, deeply bowl-shaped and the hinder part depressed, transverse groove a little more pronounced. Chromatophores yellow-green. Noted in some quantity from a swampy pool.

GYMNODINIUM AUSTRALE mihi. (Text-fig. 2 a).

Gymnodinium magnum, parte anteriore alte campanulata, sursum late rotundata; lateribus fere rectis; parte posteriore triangulari pone acuminata interdum apiculata. Chromatophoris luteo-fuscis vel luteo-viridibus, stigmatate millo.

Long. 53-56, lat. 36-38  $\mu$ .

Sydney Water Supply; Botany (92); Lismore (316).

Syn. *G. fuscum* var. *cornifax* (Schilling) Playf. in Plankt. Sydney Water, these Proceedings 1912, p. 545, Pl. lvii., f. 18, 19. A fine large species generally distributed here and apparently more common than any other. It has points of resemblance both with *G. fuscum* (Ehr) Stein, and with *Gym. (Cystodinium) cornifax* Schilling, but as it everywhere retains its own characteristics I have decided to give it a name. The anterior portion is deeply bell-shaped, broadly rounded above, with nearly straight sides somewhat everted at the transverse groove; hinder part triangular with slightly arched sides, the end acuminate or apiculate, the apiculus nearly always turned to one side, suggesting a connection with the peak of a cyst. Contents yellow-brown or yellow-green; no stigma, the spot indicated, *l.c.*, f. 18, must have been a red oil-drop. It was this species I found in company with cysts (containing the living creature) markedly agreeing

with those of *Cystodinium cornifax* (Schilling) Klebs, but the shape of the encysted organism was not distinct and I have never felt quite certain of a connection between the two. Moreover it seems to me not at all unlikely that all species of *Gymnodinium* form these cysts; for these reasons I have not placed it under *Cystodinium*.

Var ACUTUM, n. var. (Text-fig. 2 *b, c*.)

Forma major, magis ovata, præ latitudinem longior, angulis acutioribus, parte anteriore interdum rotunda nec campanulata, fossa transversa, arenata.

Long. 58-70, lat. 36-42  $\mu$ . Lismore (241, 327, 332, 347).

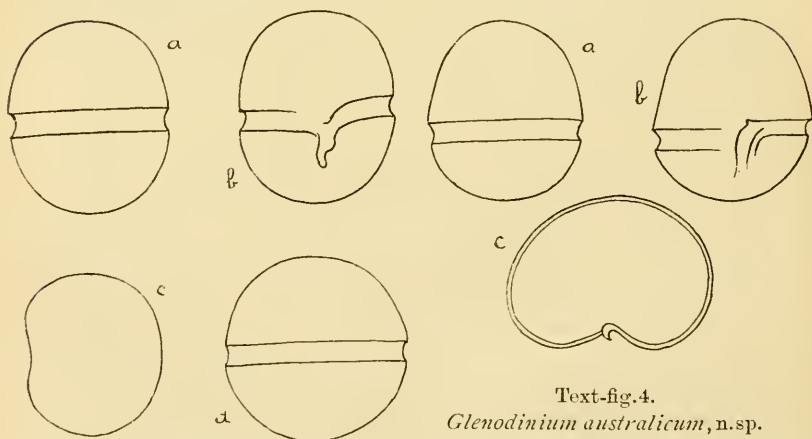
A larger form, longer in proportion to the breadth and with more pointed angles, the transverse furrow arched upwards, not straight across, the anterior part of the cell sometimes rounded and not bell-shaped.

#### Genus GLENODINIUM Ehr.

GLENODINIUM OCULATUM Stein. (Text-fig. 3 *a, b, c*.)

Long. 31-34½, lat. 26-31½, crass. 23- $\mu$ .

Botanic Gardens, Sydney (3); Lismore (312).



Text-fig.3.

*Glenodinium oculatum* Stein.

(*a*) dorsal view, (*b*) ventral view, (*c*) end view, (*d*) var. *circulatum*, n. var. (x 800).

Text-fig.4.

*Glenodinium australicum*, n.sp.

(*a*) dorsal view, (*b*) ventral view, (x 500), (*c*) end view (x 660).

An oblong or broadly oval form with hemispherical ends and almost central transverse groove, the latter somewhat spirally disposed. Our form agrees very well with Stein's figures (Naturg. d. Flagell. i.) but is half as large again according to the dimensions (long. 20-23 $\mu$ ) given by Schilling, *l.c.*

Var. CIRCULATUM, n. var. (Text-figs. 1 a, 3 d.)

Forma pæne exacte circulata, fossa transversa mediana, chromatophoris luteo-fuscis.

Long.=lat.=31-35  $\mu$ . Auburn (140); Canley Vale (94); Lismore.

In dorsal view almost exactly circular, the length equal to the breadth; transverse groove central, on the ventral side very slightly spiral. Chromatophores yellow-brown; in the type they are given as yellow-green, but these two are entirely interchangeable not only in the *Peridineae* but in other flagellates also.

GLENODINIUM AUSTRALICUM, n. sp. (Text-fig. 4).

Glenodinium magnum, latissime ovale pæne globosum, fossa transversa distincta minime spirali in partes duas maxime inæquales divisum; parte superiore alte-crateriformi, late-rotundata; parte posteriore arcuata, scutelliformi, parte superiore paullo angustiore; fossa longitudinali distincta. A vertice visum modo compressum, subreniforme. Membrana glabra.

Long. 40-45, lat. 36-40, crass. 28  $\mu$ . Botany (152).

A very broadly oval almost globose form, divided into two very unequal parts by a distinct though shallow transverse furrow which is very slightly, if at all, spiral. The upper and larger part is deeply bowl-shaped with broadly rounded end; the hinder portion arched and saucer-shaped. The longitudinal furrow is quite distinct. In end view the cell is slightly compressed, subreniform. Membrane smooth. This species reminds one of *Gl. neglectum* Schilling, and still more of *Gl. uliginosum* Schilling, *op. cit.*, pp. 24, 25, figs. 25, 28. *Gl. australicum* however is broader and more globose than either, more rounded than the former, and with the upper part less deeply bowl-shaped than in the latter. The transverse furrow also is much more shallow than in either of Schilling's species.

Genus PERIDINIUM Ehr.

PERIDINIUM CAUDATUM mihi. (Text-fig. 5 g).

Peridinium minutum, ovatum, angulatum, fossa transversa fere circulata divisum; membrana glabra. Epivalva subtriangulari-



conica, angulata, tabulis concavis, ad apicem fovea instructa apice interdum producto; tabulis æquatoriis 7, apicalibus dorsalibus 3, ventralibus 2. Hypovalva valde angulata, tabulis concavis; pone in spinas 2-3 protracta.

Long. 30, lat. 21-25, epiv. alt. 15-17  $\mu$ . Sydney Water Supply (64, 66).

Syn. *P. tabulatum* v. *caudatum* Playf., *l.c.*, p. 544, Pl. lv., f. 18. A small form and rather rare even in the slimes from the Sydney Water filters. The cell is ovate, strongly faceted, with concave plates. The epivalve almost triangularly conical with an apical pit. The apex is sometimes produced. Hypovalve depressed, very angular, with angles produced backwards into 2 or 3 short spines, plates concave. Membrane smooth.

PERIDINIUM CAUDATUM var. GUILDFORDENSE, n. var. (Text-fig. 5).\*

Peridinium minutum, subglobosum (vel ovale), glabrum, ubique rotundatum; fossa transversa tenui, modo spirali fere circulata. Epivalva conico-rotundata, lateribus, asymmetrice arcuatis, fovea subapicali instructa; tabulis æquatoriis pentagonis 7; apicalibus 4 magnis hexagonis, ventralibus 2, dorsalibus 2; tabula singula dorsali pentagona (fere quadrata) pro tabulis ventralibus disposita. Hypovalva tenuis, pæne scutelliformis, quam epivalva angustior; tabulis æquatoriis 5, antapicalibus 2, non omnibus æqualibus, modo oblique dispositis; fossa longitudinali brevi.

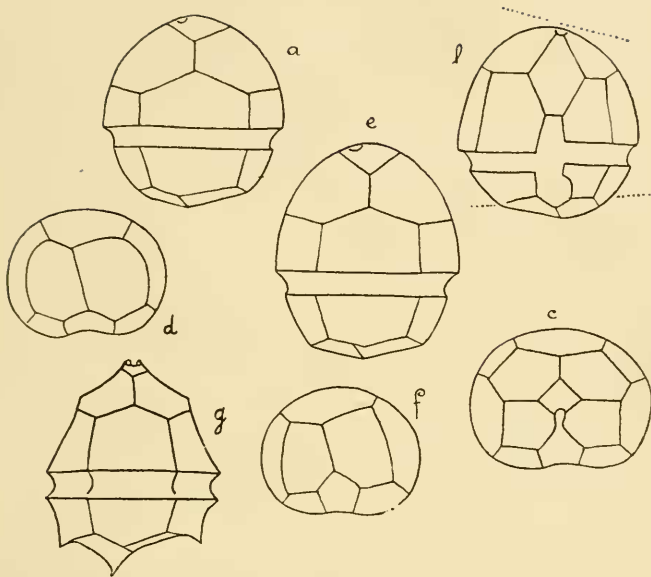
Long. 19-31½, lat. max. 17-28½  $\mu$ .

Guildford (70); Auburn (148); Fairfield (83); Botany (17); Rookwood; Centennial Park (133); Lismore (308, 316, 327, 337, 347).

A minute form first obtained in considerable quantity from a pool at Guildford. The general shape is so very broadly ovate as to be almost globose, and smoothly rounded everywhere but slightly faceted in the hypovalve. More oval specimens are also met with however. Transverse furrow very shallow, the longitudinal furrow short and distinctly defined. Hypovalve very much smaller and decidedly narrower than the epivalve, convex behind. The sides of the epivalve are unequally arched, the left side (in dorsal view) being flatter than the other, and on this side is found a slight pit which is therefore subapical. The outlines of the plates are often very delicate and with diffi-

\*In all the text-figures read thus: (a) dorsal view, (b) ventral view, c) epivalve, (d) hypovalve, unless specified otherwise.





Text.fig.5.

*a-f*, *Peridinium caudatum* var. *guildfordense*, n. var. (x 1000).

(*a*) dorsal view, (*b*) ventral view, (*c*) epivalve, (*d*) hypovalve, (*e*) more oval form, (*f*) hypovalve of same.

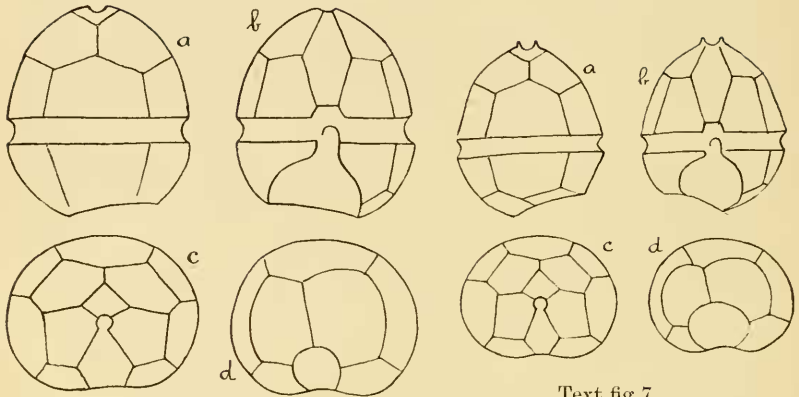
*g*, *Peridinium caudatum* mihi, forma (x 1000).

culty discernible; intercalated plates, as is usually the case here even in the largest species, being generally absent. The two antapical plates of the hypovalve are not quite equal, and are arranged obliquely. In the epivalve the rhomboidal plate is continued right into the subapical pit.

Var. *PLANKTONICUM* mihi. (Text-figs. 6, 7).

Forma late ovata, modo angulata; fossa transversa circulata. Epivalva conica, lateribus symmetricis, fovea apicali instructa. Hypovalva tam lata quam epivalva, a tergo modo excavata; fossa longitudinali valde dilatata usque ad marginem posteriorem extensa; tabulis antapicalibus modo inæqualibus, paullo oblique dispositis.

Long. 23-32, lat. 20-28  $\mu$ . Sydney Water Supply (66, 115); Brisbane.



Text-fig. 6.

Text-fig. 7.

*Peridinium caudatum* var. *planktonicum*, n. var. from Sydney (text-fig. 6) and Brisbane (text-fig. 7). (x 1000).

Syn. *P. tabulatum* var. *africanum* (Lemm.) mihi, (*P. africanum* Lemm.) *op. cit.*, p. 544, Pl. lv., f. 17. This form is not identical with *P. africanum* Lemm. (Cf. G. S. West. Frw. Algae 3rd Tanganyika Exp., p. 188, Pl. 9, f. 1) though it bears considerable resemblance to it especially when found with intercalated plates. It is a distinctly ovate form, slightly faceted, with conical epivalve the sides of which, unlike those of the preceding variation, are symmetrical, and the pit apical. The latter is sometimes quite plain, sometimes with a thickened rim and occasionally its edges appear in dorsal and ventral view as minute spines. The hypovalve is as broad as the epivalve, with a slight excavation behind, which indicates the posterior margin of the greatly dilated longitudinal furrow. The antapical plates are large, not quite equal and set somewhat obliquely—quite different from those of *P. africanum*.

Var. *MORSUM* mihi. (Text-fig. 8).

Epivalva apice in rostrum brevem truncatum producta. Hypovalva depresso pone latissime excavata.

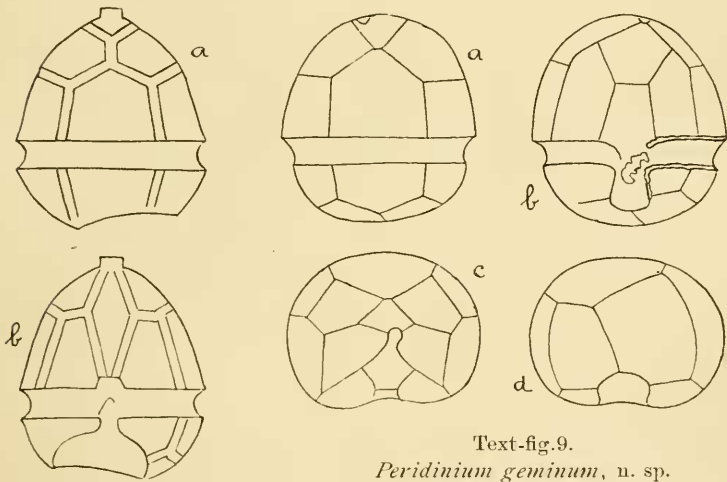
Long. 23-28½, lat. 20-26 μ. Sydney Water Supply (66); Brisbane.

Syn. *P. tabulatum* var. *pusillum* f. *morsa* Playf., *l.c.*, p. 544, Pl. lv., f. 19-21. *P. pusillum* Penard, *Perid. du Leman*, Pl. iv.,

f. 1-3, has indeed the same apical prolongatum of the apex, but this form is ruled off from any connection with it on account of the different arrangement of the plates. Cf. Schilling, *l.c.*, p. 41, fig. 45.

PERIDINIUM GEMINUM, n.sp. (Text-fig. 9).

Peridinium minutum ad *P. caudatum* var. *guildfordense* valde accedens, glabrum, subglobosum; fossa transversa tenuis. Epivalva crateriformis, fovea subapicali instructa; lateribus



Text-fig.9.

*Peridinium geminum*, n. sp.  
(x 1000).

Text-fig.8.

*Peridinium caudatum*  
var. *morsum*, n. var.  
(x 1000).

asymmetricis, arcuatis; tabulis æquatoriis pentagonis 7; apicalibus 5 (dorsalibus 3, ventralibus 2). Hypovalva tenuis, depressa, scutelliformis quam epivalva angustior; tabulis antapicalibus magnis 2, inæqualibus, oblique dispositis; fossa longitudinali brevi.

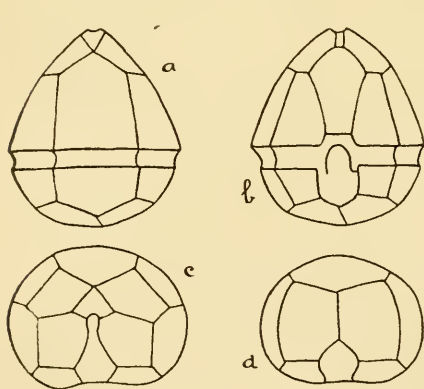
Long. 20-31, lat. epiv. 18-26, lat. hypov. 16-23, crass. 20-23 $\mu$ .  
Guildford (70); Botany (17).

Found originally in company with *P. caudatum* var. *guildfordense*, and so named from its marked similarity to that type in

dimensions and general characteristics. The arrangement of the plates in the epivalve also is on much the same lines in both, and there is a similarity in their disposition in the hypovalve. Yet on the other hand there are distinct differences which are constant, no intermediate forms have been noted, and there is a series of well-marked varieties connected with each species. The fundamental character of the species is (in dorsal view) the 4th equatorial and two dorsal apical plates meeting at a point (or nearly so) below the apex. This point in the type is about two-fifths of the altitude of the epivalve from the tip.

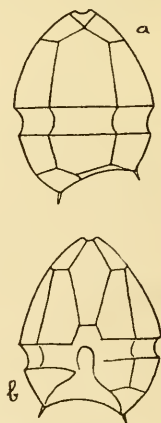
Var. *ELEGANS*, n. var. (Text-fig. 10).

Forma valde ovata, modo angulata. Epivalva conica, fere triangularis, sursum acuminata; fovea apicali instructa; lateribus symmetricis quam levissime arcuatis, fere rectis, paullulo angulatis; tabulis æquatoriis præ epivalvæ altitudinem altissimis; tabula rhomboidea sursum plus minus arcuata. Hypovalva tabu-



Text-fig. 10.

*Peridinium geminum*  
var. *elegans*, n. var.  
(x 1000).



Text-fig. 11.

*Peridinium geminum*  
var. *excavatum*, n. var.  
(x 1200).

lis antapicalibus æqualibus. Cetera ut in forma typica.

Long. 25-26, lat. 21-23, epiv. alt.  $14\frac{1}{2}$ -16  $\mu$ .

Guildford (70); Sydney Water Supply (100).

A very elegant form, quite symmetrical and markedly ovate, slightly faceted. The transverse furrow, as in the type, very

shallow, the longitudinal furrow short, and distinctly outlined. Apart from the pointed conical almost triangular epivalve, the chief characteristics are the depth of the equatorial plates in proportion to the height of the epivalve, and the rhomboidal plate, which is arched above, its outline often resembling a loop. The antapical plates are quite regular.

Var. *EXCAVATUM*, n. var. (Text-fig. 11).

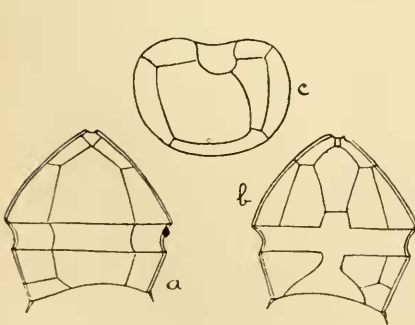
Forma ovata vix angulata. Epivalva conica, fovea apicali, lateribus symmetricis quam levissime arcuatis; tabulis æquatoriis altissimis, tabula rhomboidea longissima. Hypovalva pone oblique excavata, interdum spinis minutis binis armata; fossa longitudinali valde dilatata usque ad marginem posteriorem extensa.

Long. 16-21, lat. 14-15½  $\mu$ . Sydney Water Supply (64, 66).

A minute form, in shape like var. *elegans*, but with the hypovalve considerably excavated behind, where it is sometimes armed with a couple of minute spines. The longitudinal furrow is greatly dilated and extends right back to the hinder margin of the hypovalve. This form also has very deep equatorial plates in the epivalve. The markings were extremely faint, and I was not able to make out the end view at all.

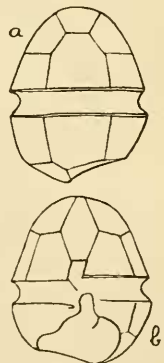
Var. *ANGULOSUM*, n. var. (Text-fig. 12).

Forma angulosa, præ longitudinem latissima, fossa transversa



Text-fig.12.

*Peridinium geminum*  
var. *angulosum*, n. var.  
(a) dorsal view, (b) ventral  
view, (c) hypovalve (x 1000).



Text-fig.13.

*Peridinium umbonatum*  
var. *inaequale*, Lemm.,  
forma. (x 1000)

tenui. Epivalva latissime conica, subtriangularis; fovea apicali; lateribus symmetricis fere rectis; tabulis æquatoris altissimis. Hypovalva valde excavata pæne truncata, interdum spinis minutissimis binis armata, lateribus rectis, fossa longitudinali latissime dilatata; tabulis antapicalibus maxime inæqualibus.

Long. 19-25, lat. 19-22  $\mu$ . Botanic Gardens, Sydney (3).

A very distinct form, but the plates in dorsal and ventral view are as in the type. The cell is very angular, the length and breadth nearly equal. The epivalve is very broadly conical and so flat in the sides as to be almost exactly triangular in optical section. The equatorial plates again very deep. The hypovalve is so deeply excavated as to be almost truncated and the widely dilated longitudinal furrow is merged in this excavation. The sides of the hypovalve are flat and the posterior angles often tipped with a minute spine. The antapical plates are very unequal, one large and almost square, the other very narrow, differing in this both from the type and from var. *elegans*. I have this form only from a tank in the Botanic Gardens, Sydney, fed by the city water.

PERIDINIUM UMBONATUM var. INÆQUALE Lemm. (Text-fig. 13).

Forma fossa transversa fere mediana, hypovalva major, vix angulata, tam lata quam epivalva; in epivalva fovea apicali nulla.

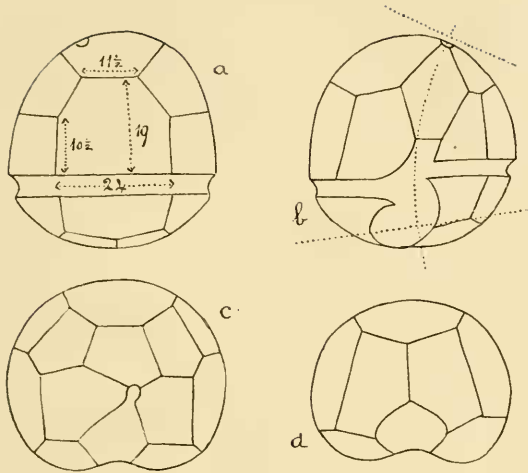
Long. 22½, lat. 19, epiv. alt. 10½, lat. foss. trans. 3  $\mu$ . Brisbane.

A single cell noted in a plankton sample from Brisbane. It does not quite agree with Lemmermann's figure given by Schilling, *l.c.*, p. 40, f. 44. The transverse furrow is nearly median, the hypovalve therefore deeper. The latter is as broad as the epivalve and hardly faceted at all. There is no apical pit, a very unusual thing in all forms of small species in our waters. I did not manage to secure end views.

Var. CENTENNALE, n. var. (Text-fig. 14).

Peridinium parvum, subglobosum, ubique, rotundatum, haud angulatum, fossa transversa in partes duas maxime inæquales divisum; fossa transversa tenui, in spira disposita. Epivalva rotundata, crateriformis, fovea subapicali instructa, lateribus asymmetricis. Hypovalva tenuissima, scutelliformis, pone convexa, multo quam epivalva minor et paullulo angustior; fossa longitudinali modo dilatata usque ad marginem posteriorem extensa; tabulis antapicalibus æqualibus, modo oblique dispositis.

Long.=lat.=30-44, crass. c. 32  $\mu$ .



Text-fig. 14.

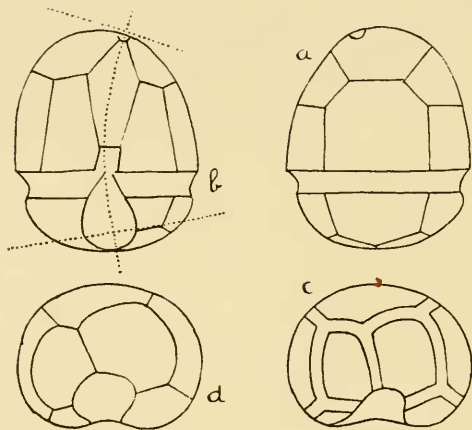
*Peridinium umbonatum* var. *centenniale*, n. var. (x 800).

Centennial Park, Sydney (133); Lismore (327).

A small form, rounded and very nearly globose, the length and breadth almost always equal. A shallow groove divides the cell into two very unequal valves, the epivalve being quite two-thirds of the total length. The latter is rounded and bowl-shaped, with unequally arched sides and subapical eccentric pit as in *P. caudatum* v. *guildfordense* and *P. geminum*. Hypovalve very shallow, saucer-shaped, a mere lid gently arched behind, a little narrower than the epivalve. Antapical plates equal (probably not always however), obliquely disposed. In these rounded forms there seem to be three kinds of antapical plates (1) angular with straight sides, (2) angular with arched sides, (3) rounded; and these appear to be interchangeable in the same form.

Var. OVALE, n. var. (Text-fig. 15).

*Peridinium parvum*, ovale, ubique rotundatum, per fossam transversam tenuem in partes duas maxime inæquales divisum. Epivalva altissima, rotundata, alte crateriformis; lateribus asymmetricæ arcuatis; fovea excentrica, subapicali. Hypovalva multo quam epivalva minor paulluloque angustior, scutelliformis, pone arcuatis; fossa longitudinali modo dilatata, usque ad marginem



Text-fig. 15.

*Peridinium umbonatum* var. *ovale*, n. var. (a) dorsal view, (b) ventral view. (c, d) two hypovalves. (x 1000).

posteriorem extensa; tabulis antapicalibus inæqualibus, oblique dispositis.

Long.  $28\frac{1}{2}$ -32, lat. 21-28, epiv. alt. 18-22  $\mu$ . Guildford (70); Lismore (337).

Practically an oval form of var. *centenniale*, though not found with it.

PERIDINIUM INTERMEDIUM mihi. (Text-fig. 16 a-e).

*Peridinium* medium, maxime angulata; fossa transversa fere circulata; membrana glabra. Epivalva quam hypovalva paullo major, angulata, ad apicem fovea distincta instructa; foveæ marginibus quasi spinis minutis protractis; tabulis concavis, æquatoriis 7; apicalibus pentagonis, dorsalibus 3 minoribus, ventralibus 2 majoribus. Hypovalva rotundata; fossa longitudinali valde dilatata, usque ad marginem posteriorem extensa; tabulis concavis, antapicalibus maxime plerumque (?) inæqualibus, angustis, excavatis.

Long. 44-46 $\frac{1}{2}$ , lat. 40-42, crass 25  $\mu$ .

Sydney Water Supply (100); Lismore (332).

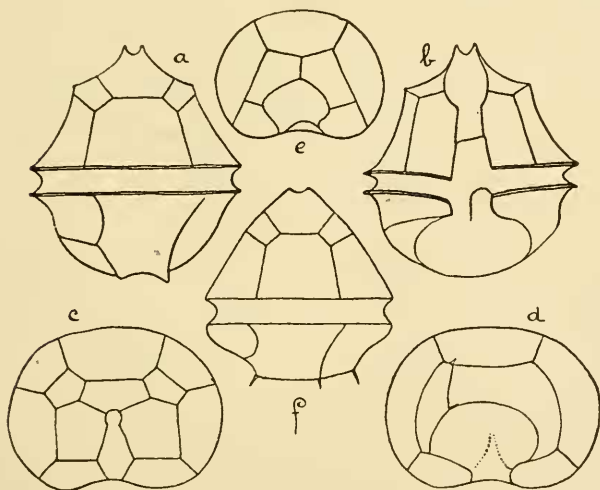
Syn. *P. tabulatum* var. *intermedium* Playf., *op. cit.*, p. 544, Pl. lv., f. 15, 16. A very distinct species this, principally char-



acterised by the two apical dorsal plates in the epivalve being very small. These show up very clearly in the dorsal view of the cell, forming the upper corners of the 4th equatorial plate. The type is very angular, being strongly faceted with concave plates. Epivalva with a strongly accentuated apical pit, the rim drawn out and appearing as a pair of minute spines. Hypovalve with longitudinal furrow greatly dilated and carried right back to the hinder edge. The antapical plates are very unequal in size and of very peculiar shape, being greatly hollowed out on the ventral side by the dilated longitudinal furrow. Specimens are occasionally found with the plates equal however.

Var. *CONICUM*, n. var. (Text-fig. 16 f).

Forma minus angulata; tabulis minime concavis. Epivalva



Text-fig. 16.

*Peridinium intermedius* mihi. (a) dorsal view, (b) ventral view, (c) epivalve, (d) hypovalve, (e) rarer form of hypovalve, (f) var. *conicum*, n. var. (x 660).

late-conica, subtriangularis; lateribus fere rectis; fovea apicali sine spinis. Hypovalva depressa, subtruncata, spinis ternis armata.

Long. 38, lat. 38, epiv. alt. 23  $\mu$ . Sydney Water Supply (100).

A neater, less strongly faceted, more regular form, with the plates only slightly concave. The epivalve is broadly conical, in optical section triangular; sides almost flat; apical pit present but less pronounced, rim not produced. Hypovalve somewhat depressed, subtruncate furnished with three small spines behind.

PERIDINIUM STRIOLATUM, n.sp. (Pl. xli., f. 1).

Peridinium magnum, ovale vel ovatum, fossa transversa circumlata (vel minime spirali) in partes duas inæquales divisum; a vertice visum multo compressum; membrana per longitudinem crasse striata. Epivalva rotundato-conica, haud angulata, ad apicem late-rotundata; tabulis æquatoriis 7; apicalibus dorsalibus 4 (medianis hexagonis 2, lateralibus pentagonis 2); tabulis apicalibus ventralibus pentagonis 2; tabula rhomboidea plerumque rotundata, circumlata vel ovali; fossa longitudinali (parte superiore in epivalva) plerumque longissima et cum tabula rhomboidea plus minus coalita. Hypovalva crateriformis, interdum plus minus angulata; fossa longitudinali pone dilatata usque ad marginem posteriorem extensa; tabulis antapicalibus æqualibus, depressis, ad latera protractis, sæpe oblique dispositis.

Long. 44-48, lat. 34-38, epiv. alt. 23-25, crass. 23  $\mu$ .

Centennial Park, Sydney (133); Botany (17).

This large handsome species is characterised by its membrane regularly longitudinally coarsely striate. In general shape it is oval, in end view compressed. The epivalve which measures nearly half the length of the cell, is bell-shaped or conical, broadly rounded above, not faceted. The hypovalve is bowl-shaped, generally faceted, equal in breadth to the epivalve. The longitudinal furrow is dilated behind and extends right back to the posterior margin of the cell. There is a tendency for this dilated portion to be shut off from the rest, the furrow being constricted and an imperfect ridge often formed. The length of the longitudinal furrow within the epivalve is remarkable and characteristic of the species in all its forms as is also the shape of the rhomboidal plate. The latter is almost always rounded, circular, ovate or oval, extending nearly to the apical margin of the valve, and seems in many cases to be merely a dilatation of the furrow. The antapical plates also have well-marked characters, being depressed and spread out laterally.

Var. RUGOSUM, n. var. (Pl. xli., f. 2).

Forma hypovalva magis angulata, tabulis concavis; tabulis an-

tapicalibus interdum inæqualibus et contortis; nonnunquam granulis vel costis brevibus in serie unica paullo infra fossam transversam ornata. Cetera ut in forma typica.

Long. 44-51, lat. 34-46, epiv. alt. 23-27, crass. 23-27  $\mu$ .

Centennial Park (133); Botany (17).

The hypovalve in this form is very irregular behind, more faceted and with plates concave; the antapical plates are sometimes (but not always) unequal and contorted. There is occasionally a single row of granules or of short costae below the margin of the transverse groove. (Pl. xlii., f. 3).

Var. TRUNCATUM, n. var. (Pl. xlii., f. 1, 2).

Forma hypovalva pone truncata, lateribus arenatis. Cetera ut in f. typica.

Long. 51-52, lat. 42-49  $\mu$ . Botany (17); Lismore (327).

Another common form; it is more or less truncate behind, with rounded sides to the hypovalve. The larger specimens in all these forms seem to be proportionately broader and less oval than the type. The striae are generally faint, but occasionally quite distinct, when they appear as rows of partly coalesced granules or serobieulae, probably the latter.

Var. ACUMINATUM, n. var. (Pl. xlii., f. 4).

Forma modo irregularis; epivalva magis acuminata.

Long. 52, lat. 46  $\mu$ . Centennial Park, Sydney (133).

A rather irregular form with epivalve more pointed above. The transverse furrow is generally slightly spiral in all the forms, its breadth in the specimen measured was 5-6  $\mu$ , of the longitudinal furrow 6-10  $\mu$ , the rhomboidal plate seems to be entirely coalesced with the latter.

Var. AUBURNENSE, n. var. (Pl. xlii., f. 5-7).

A forma typica differt solum in membrana per longitudinem levissime costata, inter costas late reticulata.

Long. 45-57, lat. 40-53, epiv. alt. 24-30  $\mu$ .

Auburn (148); Centennial Pk. (133); Lismore (297, 302, 308).

A very curiously marked form, first noted at Auburn (Sydney). The membrane is lightly costate longitudinally, the spaces between the costae being filled in with an irregular lattice work of reticulations. The same series of forms may be noted with this membrane as with the striate. Var. *auburnense* is abundant round Lismore and numerous specimens were measured, so that the range of dimensions for this form may reasonably be taken to represent those of the whole species. Transverse furrow

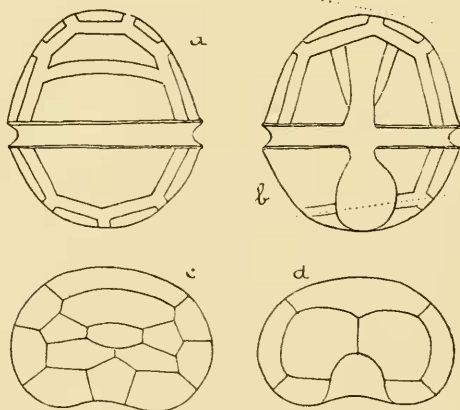
diam. 4-5  $\mu$ ; rhomboidal loop lat. max.  $12\frac{1}{2}$   $\mu$  and perhaps more. The ratio of "total length" to "altitude of epivalve" in eight specimens taken haphazard was 1.7, 1.7, 1.8, 1.8, 1.8, 1.8, 1.9, 2.0 to unity. Specimens were observed partly striate and partly latticed.

PERIDINIUM WILLEI var. AUSTRALE G. S. West. (Text-fig. 17).

Long. 37-57, lat. 40-55, crass. 32-43  $\mu$

Botany (17); Sydney Water Supply (66); Lismore (308).

Syn. *Peridinium Volzii* var. *australe* G. S. West, Algae of the Yan Yean Res., p. 80, f. 10 A-G. *P. Volzii* Lemmermann (Dr. Volz gesammelten Süßwasseralgen, 1904, p. 166, T. xi., f. 15-



Text-fig. 17.

*Peridinium willei* var. *australe* G. S. West. (x 500).

18) is practically *P. Willei* Huitfeld-Kaas wrongly drawn, and curiously enough the same error is present in the figure of the Victorian specimens. The band separating the 4th equatorial plate in the epivalve from the large dorsal apical plate has been omitted, as a comparison of the dorsal view of the cell (*i.e.*, fig. 10 B) with the diagram of the epivalve (fig. 10 C) will show. There is a slight error also in Huitfeld-Kaas' type figure, the antapical plates are reversed from right to left, the hypovalve having probably been viewed from the inside. The

smaller plate is always on the left in end view from the ventral side. This is the only European type I have so far noted here.

Var. *BOTANICUM*, n. var. (Pl. xli., f. 3).

Forma in conspectu dorsali fere circulata nec ad latera protracta; hypovalva a tergo spinis minutis binis armata; fossa longitudinali magis distincte definita.

Long. 42-60, lat. 40-60, epiv. alt. 21-30, crass. 30-37  $\mu$ .

Botanic Gardens (3); Botany (17); Canley Vale (94); Guildford (70, 77); Fairfield (83); Sydney Water Supply (100, 115); Lismore (332, 333).

Syn. *Peridinium tabulatum* in Plankt. Sydney Water Supply, p. 452, Pl. lviii., f. 1-3. In this form the cell in dorsal view is almost circular, the margins of the transverse furrow projecting very distinctly; the cell is not produced laterally in the manner which has caused the synonym *P. alatum* to be given to the type. In the hypovalve there are two minute spines on the posterior edge, and the longitudinal furrow is strictly defined. In the epivalve the plates are somewhat different in dorsal view and in end view. The three plates in a series resembling a Christmas cracker are really exactly apical and neither dorsal nor ventral. In a cell of lat. 52  $\mu$  the three together measured 40  $\mu$  long (12 + 16 + 12), lat. max. 8  $\mu$ .

*PERIDINIUM GRANULOSUM* mihi. (Pl. xliii., f. 1, 2).

Long. 49-76, lat. 53-76, crass. 63  $\mu$ .

Sydney Water Supply (66, 100); Botanic Gardens (22); Botany (109); Auburn (140); Fairfield (143); Brisbane.

Syn. *Peridinium tabulatum* var. *granulosum* Playf., *op. cit.*, p. 542, Pl. lv., f. 1-4. First found in the Sydney City water and since noted from several other localities. The arrangement of plates in the end view of the epivalve shows that it belongs to the *P. cinctum* group, but it has quite a number of distinct characteristics of its own. In size it is only equalled by *P. tabulatum* v. *meandricum* Lauterborn; the membrane is not areolate but granulate, sometimes finely and faintly, sometimes coarsely and distinctly, either in lines or scattered irregularly. There is an apical pit in the epivalve connected by a groove with the rhomboidal plate and generally bordered by two minute spines, two are present also at the back of the hypovalve. In this it resembles *P. bipes* Stein. There is a curious twisted appearance in the hypovalve, the intercalated grooves between the equatorial

plates in dorsal view do not coincide in position with those of the epivalve and also run back obliquely. The antapical plates also are uneven in size and obliquely disposed, the central suture running slantwise across from the centre of the longitudinal furrow to a point near the edge of the third equatorial plate. The longitudinal furrow is greatly dilated behind and carried right back to the margin of the hypovalve.

These peculiarities are just as distinct in specimens from Brisbane, though the latter were considerably smaller. The "crass.  $63\ \mu$ " noted above was from a Sydney specimen  $74 \times 70\ \mu$ ; those from Brisbane measured  $49 \times 46\text{-}53$ , crass.  $42\ \mu$ .

(*P. TABULATUM*) var. *OVATUM* Playf.

*Loc. cit.*, p. 544, Pl. lv., f. 14. This is a very rare form and I have not been able to secure further specimens. It is very transparent and I think the central line at the apex of the epivalve belongs to the ventral side. With long. 50, lat.  $44\ \mu$  it probably falls under *P. granulosum*. It has of course nothing to do with *P. tabulatum* but might conceivably be connected with *P. caudatum* mihi.

PERIDINIUM AUSTRALE mihi.

*Peridinium magnum*, globosum vel subglobosum, plerumque rotundatum sed interdum angulatum; fossa transversa submediana paullo spirali divisum. Membrana rugulosa, rugis per longitudinem dispositis. Epivalva hemisphærica interdum fovea apicali atque spinis minutis binis instructa, præcipue ad apicem versus compressa; tabulis æquatoriis 7; subapicalibus 3 (dorsali una latissima, ventralibus 2) et inter eas, pæne exacte apicalibus, tabulis 3 angustis (mediana minima, rectangulari) in serie transversa dispositis; tabula rhomboidea ad apicem extensa. Hypovalva hemisphærica; fossa longitudinali usque ad marginem posteriorem extensa, pone modo dilatata; tabulis antapicalibus 2, inæqualibus, coalitis; margine rotundata; sutura obscura.

Long. 44-54, lat. 42-59, crass. 31-40  $\mu$ . Sydney (Pl. xlii.,  $\times$  f. 8).

Long. 47-53, lat. 38-48  $\mu$ . Brisbane (Pl. xli., f. 4).

Sydney Water Supply (66, 100); Centennial Park (133); Botany (145); Guildford (146); Brisbane.

Syn. *Peridinium tabulatum* var. *Westii* f. *australis* Playf., l.c., p. 542, Pl. lv., f. 5-9. Formerly I considered that on account

of its ridged membrane this form should be placed under *P. Westii* Lemm. The latter, however, belongs to the *P. cinctum* group, while the diagram of the epivalve shows that *P. australe* must be grouped with *P. Willei* Huitfeld-Kaas.

The membrane is covered all over with coarse irregular disjointed ridges running longitudinally. All the plates in dorsal view are very broad. The epivalve is greatly compressed towards the apex so as to form there a transverse apical ridge composed of 3 very narrow plates which cannot be said to be either dorsal or ventral. The central one of these is small and exactly rectangular, sometimes so indistinctly delimited that all three appear to form a single plate. In the hypovalve the two antapical plates have coalesced to form a single plate with rounded outline, a slight notch on the dorsal side and an indistinct suture alone showing that the two are of unequal size.

PERIDINIUM ZONATUM mihi. (Pl. xliii., f. 3).

Peridinium magnum, globosum; fossa transversa, spirali, submediana, divisum; membrana glabra; tabulis omnibus (antapicalibus exceptis) rugis incrassatis, rectis, parallelis, binis, transverse dispositis ornatis; tabulis antapicalibus ut in *P. australi* rugulosis. Epivalva hemisphærica rotundata haud angulata; tabulis æquatoriis 7; tabulis subapicalibus dorsalibus 2, ventralibus 2; tabula apicali una, laterali una. Hypovalva hemisphærica, rotundata, haud angulata; tabulis æquatoriis 5, apicalibus 2 in tabulam unam subcirculatam coalitis.

Long. = lat. = 50-54  $\mu$ . Sydney Water Supply (100, 102, 115).

Syn. *Peridinium tabulatum* var. *zonatum* Playf., l.c., p. 543, Pl. lv., f. 10-12. This species seems to belong to the *P. cinctum* group along with *P. granulosum* and *P. Westii*. In dorsal view the markings are those of *P. caudatum* var. *guildfordense* when the cell is in a certain position, but on turning the cell a little, the edge of another (the lateral) plate comes immediately into view. The arrangement of plates in end view of the epivalve is difficult to make out exactly but seems to be on the lines of *P. cinctum*. There are 2 subapical ventral plates, 2 distinctly dorsal, one almost exactly apical and one lateral. In the hypovalve there are two antapical plates usually coalesced into one with a subcircular outline. Rarely two regular distinct antapical plates are formed (Pl. xlii., f. 9). The ridging here is that of

*P. australe*. On all the other plates of the cell there are 2 rough incrassate parallel ridges transversely disposed.

PERIDINIUM HIEROGLYPHICUM mihi.

Syn. *Peridinium tabulatum* var. *hieroglyphicum* Playf., *l.c.*, p. 543, Pl. lv., f. 13. Long. = lat. =  $5\frac{1}{2}$   $\mu$ .

Var. OVATUM, n. var. (Pl. xliii., f. 4, 5).

Forma ovata, plus minusve angulata; fossa transversa spirali in partes duas inæquales divisa; superne et a tergo spinis minutis binis sæpe ornata; zonis intercalaribus nullis. Membrana notis hieroglyphicis disjunctis ornata.

Long.  $44-46\frac{1}{2}$ , lat. 40-42, epiv. alt.  $27\frac{1}{2}$   $\mu$ . Sydney Water Supply (100).

Var. ROTUNDUM, n. var. (Pl. xliii., f. 6).

Forma late-ovalis, ubique rotundata; fossa transversa spirali in partes duas inæquales vel æquales divisa; interdum sine spinis.

Long.  $46\frac{1}{2}-48\frac{1}{2}$ , lat. 42- $44\frac{1}{2}$   $\mu$ .

Sydney Water Supply (100).

This is a very rare species, and I have not been successful in obtaining end views of the hypovalve and epivalve in any of its forms. In dorsal view all that can be seen are four plates in each half, a large central almost rectangular plate with part of one on each side, above and below. In ventral view the markings are normal, with a well-defined longitudinal furrow hardly dilated behind but running right back to the posterior margin; in the epivalve the rhomboidal plate extends quite up to the apex. In all forms the membrane is covered with irregular incrassate markings.

Genus CERATIUM Schrank.

CERATIUM HIRUNDINELLA O. F. Muller.

Long. 244-324, lat. 50-63, corn. apic. 113-144  $\mu$ .

Sydney Water Supply; Auburn.

Our specimens agree very well with the excellent figure given by Schilling, *op. cit.*, fig. 62, but the apical horn is perfectly straight and the antapical horns not quite so sharp-pointed. I have not yet observed any of the depressed forms commonly noted in European waters.



*Mihi incertae sedis.*

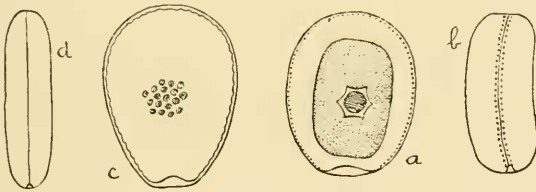
## Genus EXUVIELLA Ehr.

EXUVIELLA LIMA (Ehr.) Schutt. (Text-fig. 18 a, b).

Membrana levis vel punctata.

Long. 30-33, lat. 21-26, crass.  $10\frac{1}{2}$ -15  $\mu$ .

Canley Vale (94); Fairfield (112); Botanic Gardens (125); Centennial Park (133).

Syn. *Dinopyxis laevis* Stein; *Xanthodiscus Lauterbachii* Sche-wiakowski. Found in freshwater only in Australia; a marine

Text-fig. 18.

(a) *Exuviella Lima* (Ehr.) Schutt, (b) side view (x 660); (c) var. *major*, n. var., (d) side view. (x 500).

organism, apparently, elsewhere. Cf. Stein, Naturg. d. Flagell., ii., T. 1, f. 27-33; Schutt, *Gymnodiniaceae*, p. 8, fig. 9.

Var. SCROBICULATA, n. var.

Membrana crasse scrobiculata; areolata etiam. Dimensiones ut in forma typica. Cum priori.

The type, as Stein's synonym shows, has a clear membrane, but specimens may be found finely punctate. With them however are often found others with every degree of scrobiculation, even to being areolate. These scrobiculae are on the inner side of the membrane. The test consists of dorsal and ventral valves merely adhering to one another longitudinally by the rims, not overlapping as in the *Diatomaceae*. The dorsal valve is simply slightly flattened at the end while the ventral one is deeply notched at the same place. Along the suture in each valve is a series of markings resembling the carinal dots in the diatomaceous genus *Nitzschia*, but these are not always present. The valves in side view almost always appear somewhat curved. I have noted a smaller size than those given above—long. 25, lat. ?, crass. 8  $\mu$ .

Var. MAJOR, n. var. (Text-fig. 18 *c, d*).

Forma duplo major, ovalis vel ovata; membrana crasse scrobiculata. A latere visa lineari-elliptica, haud curvata, apicibus rotundatis.

Long. 48-52, lat. 36-38  $\mu$ . Botany (109).

A much rarer form almost double in length to the usual specimens commonly found here. Such as I noted were linear-elliptic in side view, not curved, with rounded ends. Membrane coarsely scrobiculate on the inside.

#### EXPLANATION OF PLATES XLI.-XLIII.

All figures x 660, unless otherwise specified; (*a*) dorsal view, (*b*) ventral view, (*c*) epivalve, (*d*) hypovalve.

##### Plate xli.

Fig. 1.—*Peridinium striolatum*, n. sp.

Fig. 2.— „ „ var. *rugosum*, n. var., (*c*) hypovalve.

Fig. 3.— „ „ *Willci* var. *botanicum*, n. var., (*d, e*) two types of hypovalve.

Fig. 4.—*Peridinium australe* mihi, from Brisbane.

##### Plate xlii.

Fig. 1.—*Peridinium striolatum* var. *truncatum*, n. var., dorsal view.

Fig. 2.— „ „ „ „ another specimen, ventral view.

Fig. 3.—*Peridinium* „ „ var. *rugosum*, n. var., (*b*) hypovalve.

Fig. 4.— „ „ „ „ var. *acuminatum*, n. var.

Fig. 5.— „ „ „ „ var. *auburnense*, n. var.

Fig. 6.— „ „ „ „ another specimen, ventral view.

Fig. 7.— „ „ „ „ scalariform markings, greatly enlarged.

Fig. 8.—*Peridinium australe* mihi, from Sydney; (*b*) epivalve, (*c*) usual hypovalve, (*d*) unusual hypovalve with intercalated plates.

Fig. 9.—*Peridinium zonatum* mihi, rare form of hypovalve with intercalated plates.

##### Plate xliii.

Fig. 1.—*Peridinium granulosum* mihi, from Sydney, (*c*) hypovalve (x 500).

Fig. 2.—*Peridinium* „ „ from Brisbane, (*c*) hypovalve.

Fig. 3.— „ „ *zonatum* mihi, (*d*) hypovalve (x 500).

Fig. 4.— „ „ *hieroglyphicum* var. *ovatum*, n. var., dorsal view.

Fig. 5.— „ „ „ „ another form, ventral view.

Fig. 6.— „ „ „ „ var. *rotundum*, n. var.